B.C. Ministry of Forests
Forest Science Program

Fisheries Target Risk Assessment
Prepared for the CCLUP Integration Process
by
the Fisheries Target Committee

August 15, 1996 Fisheries Target Risk Assessment

Executive Summary

The purpose of the Fisheries Target Committee was to identify how well short term timber sources can be reconciled with long term fisheries targets in the CCLUP area. We interpret "fisheries targets" to be no net loss of fish habitat due to cumulative watershed disturbance.

Due to the large size of the plan area and the limited time available, the methods used for identifying potential resource conflicts were largely determined by the nature of readily available information. The Integration Committee provided seral stage data on each biodiversity unit for current conditions and for conditions in 2016 which would result with the proposed timber harvest.

We assumed that cumulative impacts to fish habitat would be directly related to the amount of harvesting or other disturbance at any given time, as indicated by seral stage distribution on crown land. We also assumed that risks to fish habitat would be greater in areas with steeper slopes and higher precipitation so we categorized the terrain hazard for each biodiversity unit. We considered the moderating influence of large lakes in estimating terrain hazards.

Using the above information, we rated the potential risks to fish habitat for each biodiversity unit that is a watershed. Because "cumulative effects" is a watershed concept, it does not apply to biodiversity units that are not watersheds. However, we rated the potential fisheries risks to aggregates of biodiversity units which make up larger watersheds named in the CCLUP. This accounts for cumulative effects from most of the non-watershed biodiversity units.

Our fisheries risk estimates rank biodiversity units and watersheds according to potential fish habitat impacts resulting from the combined effects of timber harvesting on crown land, development of private land, and natural disturbance. They are presented as first approximations of actual fish habitat impact. This is appropriate for their intended use which is to help ensure that fisheries targets are met at the landscape level and to help prioritize the gathering of additional information in the form of watershed assessments and monitoring. Due to the simplifying assumptions required for this analysis, the fisheries risk for any individual watershed would be superceded by site specific assessments.

Among our recommendations are that watershed assessments be initiated in those watersheds named in the CCLUP as needing controls on the rate of harvest and ranked as having high fisheries risks in 1996, unless such assessments are already in progress.

Fisheries Target Risk Assessment

Introduction

The tasks the Fisheries Target Committee undertook were:

a) identify potential conflicts between the Short Term Timber Availability Assessment and fisheries targets,

b) suggest methods for improving the accuracy of fisheries risk estimates, and

c) suggest methods for reconciling the Short Term Timber Availability Assessment with long term fisheries targets in the CCLUP.

In order to meet the objectives for such a large area within a short time, the Fisheries Committee used seral stage data provided by the Integration Committee as an indicator of hydrologic recovery and equivalent clearcut area (ECA) in each biodiversity unit. We then categorized biodiversity units according to terrain hazard and used these two criteria to estimate potential risks to fisheries. Our method was therefore similar to a rate-of-cut analysis with the addition of a terrain hazard indicator.

Background

The Fisheries Committee was set up by the Integration Committee for the Cariboo-Chilcotin Land Use Plan to contribute to the short term timber availability assessment (STTAA). While the Land Use Plan determines where timber harvesting will occur on a very broad scale and within established targets, the STTAA will identify more specifically the location of the planned harvest and the short term impact of the planned timber harvest on meeting the targets in the CCLUP. The Fisheries Committee is responsible for assessing the initial proposal for timber harvest to determine the impact of proposed harvesting on fisheries resource targets and strategies in the CCLUP. The committee considers "fisheries targets" to mean no net loss to fish habitat.

Use of Biodiversity Units in Identifying Fisheries Concerns

The CCLUP, Appendix 3, identifies fish and wildlife objectives for zones and sub-zones (see Appendix A). For example, it was stated that the Horsefly watershed be managed for hydrologic stability and for salmon stocks through riparian protection and controls on the rate of harvest. These objectives apply to an area which encompasses several biodiversity units.

The objectives of the Fisheries Target Committee include identifying potential problems at the CCLUP biodiversity unit level; however, fisheries concerns must be addressed at the watershed level. Therefore, as an initial exercise, we categorized biodiversity units according to watersheds named in the CCLUP and highlighted the management objectives for those units.

The result of this is Appendix A of this document, which lists watersheds named in the target section of the CCLUP Final Report as having specific management objectives for maintaining fisheries values. These objectives include riparian protection and controls on the rate of harvest for 17 watersheds and other management objectives for five watersheds of very high concern. Appendix A also lists the SRDZs, IRMZs, and ERDZs under which watersheds were named.

Other watersheds not identified in the CCLUP were also delineated and briefly analysed in this study in order to provide useful information for identifying future planning needs.

Estimating Cumulative Watershed Impacts

One of the critical tasks of the Fisheries Target Committee was to interpret the fisheries objectives of the Land Use Plan with respect to present and future status of biodiversity units. Seral stage information on each biodiversity unit was provided by the Integration Committee, allowing analysis of those biodiversity units which are watersheds. We used the assumptions below to estimate potential cumulative impacts for biodiversity units that are watersheds and also for groups of biodiversity units that make up larger watersheds. Cumulative downstream effects only apply to a

stream channel and its contributing watershed. Therefore, we did not estimate cumulative impacts for biodiversity units that are not watersheds. Where applicable, impacts from those biodiversity units are included in the estimate of total cumulative impacts for larger watersheds. For example, the Black Creek biodiversity unit is not a watershed, but cumulative impacts from it are included in the fisheries risk calculation for the Horsefly River. The assumptions are:

- Negative impacts to fish habitat tend to increase in proportion with the percent of watershed area that is in a disturbed condition at any given time.
- The major disturbances that are of concern for this report and which can be estimated at the landscape level are timber harvesting on crown land and deforestation of private land.
- Cumulative impacts on fish habitat are mainly caused by sediment deposition in channels, channel instability, the destabilization of streambanks, and changes in water flow, temperature, and quality. These can result from road building, logging unstable slopes, disturbance of riparian areas, and increased peak streamflows resulting from timber removal (eg. IWAP Guidebook 1995 Appendices 8 and 9, Rood and Hamilton 1995). These disturbances occur on both crown land and private land.
- Cumulative impacts due to the above factors can be approximated from equivalent clearcut area and terrain characteristics.

Estimating Equivalent Clearcut Area

The concept of equivalent clearcut area (ECA) is used in the Watershed Assessment Procedure to estimate the effect of timber removal on peak streamflows. However, in this report it is used as an indicator of all cumulative impacts. This reflects the broader targets and strategies in the CCLUP which aim to manage specific watersheds for salmon stocks[1]. The downstream impacts of forest roads and timber removal tend to be greatest in the decade or so after logging and decrease as the forest grows back.

The fisheries target committee estimated tree height as a function of seral stage using professional judgement and personal experience. We then calculated equivalent clearcut area for each biodiversity unit from tree height as described in the Interior Watershed Assessment Procedure Guidebook (IWAP). Because we used seral stage data, natural disturbance is treated as equivalent to logging. The Guidebook includes logging, burns, and large slides as contributing to ECA (IWAP Guidebook Appendix 8). The accuracy of these ECA estimates can be improved by methods described later in this report.

The fisheries target committee made the following additional assumptions in order to associate seral stages and private land with equivalent clearcut area.

- An average of 85 percent equivalent clearcut (i.e. 15% hydrologic recovery) in the < 40 year old seral stage.
- An average of 85 percent equivalent clearcut (i.e. 15% hydrologic recovery) on private land.
- An average of 40 percent equivalent clearcut (i.e. 60% hydrologic recovery) in the 40 year to Mature seral stage (40 - 100 or 40 - 120 years dependent upon species).
- Zero percent equivalent clearcut (i.e. 100% hydrologic recovery) in the Mature and Old Growth seral stage (over 100 or over 120 years dependent upon tree species).

In most cases, the consideration of private land does not significantly affect ECA estimates. However, in several biodiversity units and a few watersheds, the percentage of private land is substantial (i.e. over 10 percent) and 85 percent ECA may be an overestimate at any given time. However, extensive timber removal from private land over the next 20 years is possible. Therefore, we chose to use a high equivalent clearcut for private land to reflect the potential risk to fisheries in the future. Actual risk to fisheries at any given time and in any given watershed can be

better estimated by using more detailed inventory and analysis methods. This could consist of a recalculation of fisheries risk by our method using site specific information or a more detailed method such as the IWAP. However, the problem remains of not being able to predict future timber removal from private land.

Hydrologic integrity of stands varies depending upon site-specific conditions. The actual cumulative effects may vary from the estimated ECA in individual watersheds. However, the seral stage method allows us to estimate cumulative impacts for conditions in 1996 and 2016 with the planned timber harvest, for use at the strategic planning level.

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[1]The fisheries target committee identified an intent to address cumulative impacts to fish habitat through statements in the CCLUP, such as that in the fisheries sectoral strategy stating that management of high priority watersheds emphasizes analysis and planning to "avoid cumulative impacts from future development activities" (p. 170). The strategy further identifies general objectives to "maintain the physical and biological diversity of fish habitats...maintain watershed and stream channel integrity and stability...maintain and/or enhance water quality and water quantity for instream uses" (p. 168).

Estimating Risks to Fish Habitat

The Fisheries Target Committee designed the fisheries risk estimate to indicate the probability that there would be a net loss to fish habitat due to cumulative watershed impacts. For example, "High" fisheries risk in a watershed means we expect a higher probability of some habitat loss than in a watershed rated as having "Low" or "Moderate" fisheries risk. Later in this report, we compare fisheries risk estimates with Level 1 IWAP results and other indicators of cumulative impacts.

Fisheries risks were estimated from the ECA, as described above, and the terrain hazard of each watershed for which information was available. Terrain hazards were categorized as low, moderate, or high for each biodiversity unit by reference to a Landsat photomosaic and topographic maps. We considered steepness of terrain, precipitation, distribution of forest land, and previous studies (Triton Environmental Consultants 1993).

The potential channel changes linking forestry activities with fisheries risk include increased suspended sediment concentration, decreased water quality, increased peak streamflow, and decreased physical habitat diversity. We assumed that fisheries risks increase with increasing slope steepness and precipitation and that large lakes reduce downstream impacts associated with landslides and suspended sediment.

Fisheries risks were reported as low, moderate, high, and very high for conditions in 1996 and 2016. Table 1 shows the combinations of ECA and terrain hazard by which we determined the risks. These are our estimates of relative probabilities that a biologically significant impact will occur. Furthermore, as discussed below, they are also a first approximation of actual fisheries risk for landscape level planning purposes.

We recognize the concept of magnitude and frequency in the occurrence of negative impacts. Where cumulative impacts occur, they are the result of many events of low magnitude and fewer events of larger magnitude. However, impacts in individual watersheds are the result of highly variably meteorologic events superimposed on site specific conditions. We use "cumulative impacts" to include the combined effects of many small events and a few large events which occur over a period of years. Similarly, our fisheries risks are intended to represent the impacts associated with the effects of all magnitudes of events.

Fisheries Risks						
Terrain Hazard	**ECA Estimated from Seral Stage Data**					
	0-15%	15-20%	20-25%	25-30%	30-35%	35%+
Low	low	low	moderate	moderate	high	high
Moderate	low	low	moderate	high	high	very high
High	low	moderate	high	high	very high	very high

Table 1. Matrix for Estimating Fisheries Risks

Information Used

- Seral stage data provided by the Integration Committee which identifies, by biodiversity unit, the percentage of the total forest area in 'early', 'mature', and 'mature plus old' categories.
- Total land area and private land area by biodiversity unit.
- CCLUP fisheries targets and strategies identified in Appendices 3 and 4.
- Assumptions of hydrologic recovery for each seral stage and for private land as discussed above.

Results

Table 3 contains a variety of information on biodiversity units arranged by larger watersheds named in the CCLUP. The geographic extent of the larger watersheds is closely approximated by the listed biodiversity units but is not exact. Table 3 lists total area, area of private land, ECA's, terrain hazard, and fisheries values for each biodiversity unit. Estimated fisheries risk is reported for each terrain unit that is a watershed.

The calculated ECAs in 1996 and 2016 are presented as indices of cumulative effects at the downstream end of watersheds. For those biodiversity units which are not watersheds, the estimated ECA's are an estimate of local cumulative effects but they do not correspond with any particular watershed. Therefore, fisheries risks are not reported for these units. The cumulative effects contributed by those biodiversity units which are not watersheds are accounted for in the fisheries risk values for the larger watershed in which they occur.

Our estimates for 1996 indicate that there is a high or very high risk that fisheries targets will not be met in 18 biodiversity units. When data on the Biodiversity Units are combined into larger watersheds, it indicates that fisheries targets are at high risk in the Horsefly River, Cottonwood River, Bridge Creek, Beaver Creek, Nazko River, Baker Creek, Canim Creek, Narcosli River, and Williams Lake Creek.

Our estimates for 2016 indicate that there is a high or very high risk that fisheries targets will not be met in 27 biodiversity units with the proposed timber harvest. It also indicates a high or very high risk in the Horsefly River, Cariboo River, Cottonwood River, Bridge Creek, Baezaeko River, Beaver Creek, Nazko River, Quesnel River, Baker Creek, Canim Creek, Churn Creek, Euchiniko River, Narcosli River, Williams Lake Creek, and Willow River with the proposed timber harvest.

Fisheries Risks were not calculated for biodiversity units which are not watersheds so our results may not detect some areas with high fisheries risk.

Fisheries Risk calculations for watersheds identified as "incomplete" in Table 3 are subject to revision.

Comparison of Fisheries Risks with Estimates of Cumulative Effects by Other Methods

We compared ECA's obtained from the seral stage data as described herein with watershed assessments that have been completed for the same areas. Level 1 Hazard Indices have been calculated for a number of watersheds as listed in Table 2 (Cariboo Forest Consultants Ltd, 1996; BioTerra Consulting, 1996; Dobson Engineering Ltd, 1996). This allows our method of estimating potential fisheries risks at a landscape level to be compared with a more detailed assessment of cumulative effects.

Table 2 lists the fisheries risk estimates in 1996 for eight combinations of biodiversity units which correspond geographically with watersheds that have been assessed using the Level 1 IWAP. The last column is an interpretation of whether the fisheries risk estimate would have served the purpose of screening watersheds for the Level 1 IWAP. We consider the fisheries risk estimates to be appropriate as a first approximation in all eight cases becasuse there were no instances of a "Low" or "Moderate" fisheries risk being contradicted by a Level 1 IWAP result on the same watershed. Instances of a "High" fisheries risk and "No" concern from the Level 1 IWAP are appropriate if the fisheries risk estimate is used as a first approximation pending the availability of more detailed information from the IWAP.

The results for the MacKay River biodiversity unit illustrate one of the limitations of a landscape scale of survey such as this. The moderate fisheries risk of the biodiversity unit as a whole reflects cumulative effects below the junction of the MacKay and Upper Horsefly Rivers. However, in the watershed assessment, these two rivers were each identified as having high fisheries values and were found to differ considably in their levels of cumulative effects. This information is being used to make forest development recommendations for the MacKay and Upper Horsefly Rivers individually. Risks to small high value streams are addressed by the watershed assessment procedure in those cases where the IWAP is implemented for planning purposes.

Biodiversity Unit	**Fisheries Risk, 1996**	**Watershed Name**	**Does Level 1 Watershed Assessment indicate a concern?**	**Evaluation of Fisheries Risk Estimate**
Mckinley	High	Mckinley Ck.	No	Appropriate
McKusky	High	McKusky Ck.	Yes	Appropriate
Moffat	High	Moffat Ck.	Yes	Appropriate
Mackay	Moderate	Mackay R. and Upper Horsefly R.	MacKay R. - Yes Upper Horsefly - No	Appropriate
Murphy Lake plus Bradley Creek	High	Eagle and Bradley Creeks	No	Appropriate
Baker plus Tibbles	High	Baker Creek	No	Appropriate
Swift	Low	Little Swift R. and McMartin Creek	Little Swift River - No McMartin Ck. - No	Appropriate
Cottonwood Total (Ahbau, Swift, Lightning, Umiti, and Victoria)	High	Cottonwood River	Yes	Appropriate

Table 2. Comparison of Fisheries Risk Estimates and Level 1 Watershed Assessments

The fisheries risks reported herein and the Level 1 watershed assessments are indirect indicators of cumulative impacts to fish habitat. Direct assessments of fish habitat conditions are extremely labor intensive and cannot be done for a large area in a short period of time. It is for this reason that surrogate indicators, such as our fisheries risks for biodiversity units and Level 1 watershed assessments are used. It should be noted that the Level 1 watershed assessment results are not an absolute measure of fish habitat impact. They are best used as a screening tool to help a

stakeholder committee decide whether more detailed assessments should be done.

Suspended sediment data have been collected in McKinley Creek, McKusky Creek, Moffat Creek, and the Horsefly River since 1994 (Teti, 1996, pers. comm). These results confirm the estimated high fisheries risks in Moffat Creek, but do not confirm high fisheries risks in McKinley and McKusky Creeks. For the Horsefly River, the suspended sediment data are not inconsistent with the high estimated fisheries risk for the Horsefly given in Table 3.

A hydrometric trend analysis was done for gauged watersheds within the Horsefly River system in order to look for changes as a result of forest development (Dobson Engineering Ltd., 1995). This analysis found no clear evidence that forest development has affected peak streamflows or annual water yield. The consultant concluded that this was not unexpected given the large amount of development that is typically required in order to detect changes in streamflow regime.

Based on the above discussion and the results shown in Table 2, we suggest that if they are properly used, the fisheries risk estimates reported herein are appropriate first approximations of cumulative effects on fish habitat. We suggest that "Low" and "Moderate" fisheries risks are reasonably good indicators that fish habitat at the downstream end of the watershed is not at high risk and that the risks in general are appropriate strategic level estimates for landscape level planning. The "High" and "Very High" categories indicate that fish habitat is at high risk, in lieu of more detailed information.

Suggested Methods for Improving the Accuracy of Fisheries Risk Estimates

The fisheries risks in Table 3 are presented as first approximations of potential cumulative impacts for watersheds in 1996 and 2016. These are based on seral stage and terrain hazard data which are surrogates for site specific information. The accuracy of the analysis used herein could be improved in one or more of the following ways:

- Repeat the fisheries risk calculations for high value watersheds within biodiversity units which were classified in Table 3 as non-watershed units. These areas would be smaller than the biodiversity units so it would be appropriate to collect data and do the calculations only for watersheds with high value fish streams.

- Develop an empirical relation between tree height and seral stage in order to verify or change the assumed relationship. Recalculate fisheries risks for 1996 or 2016.

- Conduct an overview of cumulative effects in watersheds which extend outside of the CCLUP area, but which are named in the CCLUP, using the methods of this report or refinements as described above. These watersheds include the Bowron (where assessments have estimated ECA at approximately 30%), Atnarko, and Bonaparte. Other watersheds straddling the CCLUP boundary and not identified in the CCLUP, such as the Willow and Hotnarko, can also be assessed in order to provide information relevant to future planning, consistent with the CCLUP.

For the higher risk and higher priority watersheds:

- Estimate cumulative downstream impacts and sensitivity to disturbance by the methods described in the IWAP Guidebook and Channel Assessment Procedure (not yet published).

- Perform terrain mapping at an appropriate level as described in the Mapping and Assessing Terrain Stability Guidebook.

Suggested Methods for Integrating Fisheries Targets with Forest Development

One of the purposes of the IWAP is to give managers a tool for minimizing impacts to fish habitat while planning forest development. Under section 32 of the Operational Planning Regulations of the Forest Practices Code, a forest district manager can require that a watershed assessment be done before a forest development plan is approved.

However, watershed assessments need not be required under section 32 of the Operational Planning Regulations in order for the inventory information to be collected and for it to be of use to resource agencies. For example, watershed assessments can aid in the planning of restoration work and can provide background justification for management recommendations by agencies responsible for referrals.

The time required to perform watershed assessments and the availability of qualified professionals are significant limitations to carrying out this work over a large geographic area in a timely manner. In the interim, district managers, other resource managers, and designated Forest Practices Code officials can make use of this report, the Integration Report, other CCLUP strategies, and results of watershed assessments which are completed or currently underway as indicated on the map in Appendix B.

It should also be noted that the IWAP is only a set of guidelines. Other assessment methods may be more efficient in some watersheds. For example, it may be appropriate for a professional to perform a detailed assessment of a watershed instead of a Level 1 assessment. If a sufficiently skilled person is available for this work, and if a stakeholder group reaches consensus on the results, it may be possible to resolve critical issues within weeks rather than months by this method.

A watershed assessment should not be viewed as a simple deterministic process. As the above examples indicate, the most important part of a watershed assessment may be a stakeholder committee which represents fisheries, timber, and other resources. If a committee is properly formed and if it reaches consensus, then the assessment and recommendation process may be accellerated. Another way of providing useful information to managers is to initiate a monitoring program for key parameters, such as suspended sediment or spawning gravel quality. The prescription and interpretation of such a program is best done by a small group of specialists, such as fisheries biologists and hydrologists. This type of program is not able to provide quick answers but with interpretation by professionals, it can provide valuable information to managers after several years.

In some watersheds, it is possible that hillslope and stream restoration will help reverse existing cumulative impacts. The Watershed Restoration Program was established to facilitate and provide funding for these types of activities. This program has been initiated in the CCLUP area and is expected to help integrate fisheries targets with forest development.

A common feature of the above methods is the involvement of stakeholders. At present, stakeholder groups exist for planning watershed restoration, for conducting watershed assessments, and for overseeing monitoring projects in several watersheds within the CCLUP area.

Recommendations

For watersheds ranked as having high or very high fisheries risks in 1996 (Table 3), but not already being assessed by a Level 1 IWAP (Appendix B), the Fisheries Target Committee strongly recommends that:

- Fisheries Risk Estimates be improved with more accurate inventory data.

For watersheds named in the CCLUP as needing controls on the rate of harvest (Appendix A), and which are confirmed to have high or very high potential fisheries risks, the Fisheries Target Committee strongly recommends that:

- multi-agency round tables be established to initiate, coordinate, and interpret watershed assessments, and to recommend restoration and monitoring activities in order to help district managers meet the requirements of the higher level plan.

Conclusion

This review identifies potential issues at the broad strategic level. Components of the Land Use Plan relating to

riparian management, water management planning/strategies, quality lakes, and enhanced fisheries/tourism are equally important in protecting and enhancing fish, fish habitat and fisheries. These issues could not be addressed with the time and data available in this study. The review does not address localized and site-specific concerns related to forest practices. Thus, it does not replace consideration of fisheries resources and habitat in planning processes designed to address either a smaller scale or other aspects of the impact of land and water use on fish habitat. This assessment assumes that the Forest Practices Code and guidebooks will be applied to forest harvesting in order to minimize site specific impacts to fish resources.

Acknowledgements

The Fisheries Target Committee consisted of the following:

Maurice Lirette, R.P.Bio., Fisheries Biologist, B.C. Environment, Fisheries Branch. Patrick Teti, P.Geo., Research Hydrologist, B.C. Forest Service. Coral DeShield, Fisheries Biologist, Fisheries and Oceans.

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Prepared for Department of Fisheries and Oceans.

Appendix A

Table A1

Management Objectives for Watersheds Named in Appendix 3 of the CCLUP Final Report and Sub-zones in which those Watersheds are Referenced									
Management objectives identified in the CCLUP							Sub-zone in which watershed is referenced		
Watershed	Riparian Protection	Control Rate of Harvest	Hydrologic Stability	Watershed Assessment	Monitoring	Restoration	SRDZ	IRMZ	ERDZ
Horsefly	x	x	x	x	x	x	AM		5,8
Cariboo	x	x	x	x	x	x	LM		4
Cottonwood	x	x	x	x	x	x	L		4
Bonaparte	x	x	x	x	x		DEI	G	10,11,12
Bridge Ck.	x	x	x	x	x		E		
Quesnel	x	x					M		3
Atnarko	x	x					C	B	
Bowron	x	x					LM		5
Beaver	x	x							5
Chilko	x	x					B		
Taseko	x	x					B		1
Baezaeko	x	x					F		
Chilcotin	x	x						C	2
Nazko	x	x						C	
Dean	x	x					F		
Hazeltine	x	x							5
Edney	x	x							5

Clinton							1		
Baker						x			2

Appendix A - cont.

The CCLUP includes fisheries and hydrology components which aim to maintain and restore fish and other aquatic resources, as well as maintain hydrologic functions within watersheds. A brief overview of fish targets, relevant for the purposes of the STTAA, follows. Details can be found in Appendices 3 and 4 of the CCLUP Final Report.

Riparian Protection The targets identify management for salmon stocks through riparian area protection for high priority watersheds identified in Appendix 3. (Eg. p. 61)

Rate of Harvest The targets identify management for salmon stocks through restrictions on rate of harvest for high priority watersheds identified in Appendix 3. (Eg. p. 61)

Hydrologic Stability The targets identify management for hydrologic stability in high priority watersheds identified in Appendix 3. Also identified is the need for watershed assessment, restoration, and monitoring in specific cases. (Eg. p. 61)

Specific Management Goals Specific areas are identified for management as quality stream fisheries or as a community watershed in Appendix 3. (Eg. p. 71)

Watershed Assessment Watershed Assessment Procedure is identified as required in key watersheds in order to ensure the maintenance of critical fish and wildlife habitats and hydrological stability. (P. 160)

Watershed Level Analysis High priority watersheds classified by Department of Fisheries and Oceans as enhanced are prescribed a level of management that emphasizes watershed level analysis in order to assess past impacts and provide the basis for watershed level planning to avoid cumulative impacts. (P. 170)

Other Management Other types of management may be required in specific cases in order to manage for fish or fish habitat. These include detailed watershed plans, assessment, management actions (such as rate of cut adjustments, wider streamside management zones, etc.), and monitoring (p. 170).

Managing watersheds for hydrologic stability and for salmon stocks through controls on the rate of harvest requires assessment and planning at the watershed level. Sectoral strategies in Appendix 4 state that, "Key or sensitive watersheds should be selected for intensive research/monitoring to assess hydrologic and water quality impacts of logging" (p. 164). Some watersheds require "watershed level analysis in order to assess past impacts of watershed level planning to avoid cumulative impacts from future development activities" (p. 170). Specific requirements include: "detailed watershed plans,... assessment, ... rate of cut adjustments, wider streamside management zones, provisions for fisheries resource maintenance flows, site specific stream protection and restoration measures [and] monitoring" (p. 170). Further, strategies in Appendix 4 include to "assess present and potential development impacts in fisheries watersheds ... and implement *integrated watershed management plans ... to minimize the cumulative impacts* of land use activities" and to "conduct fish habitat inventories to identify fisheries sensitive/critical areas that require protection and site specific management actions" (p. 168, italics added).

Appendix B

Map of biodiversity units ranked as having High fisheries risks in 1996 and areas where watershed assessments are in progress (not yet available).

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